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CHANGES IN THE VESTIBULAR SYSTEM WITH AGE:

AN ABSTRACTED BIBLIOGRAPHY

J. Michael Lentz, J. G. Pollack, and Fred E. Guedry, Jr.

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CHANGES IN THE VESTIBULAR SYSTEM WITH ACE:

AN ABSTRACTED BIBLIOGRAPHY

Naval Medical Research and Development Command  
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30 April 1981

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## PROLOGUE

The following abstracted reports emphasize the change, apparently related to age, of the human vestibular system. Some representative animal studies are included, but the search for animal studies was not exhaustive.

An attempt was made to choose articles that compared functional abilities across age groups. In some cases, reports on a rather limited subject age range are included, particularly if the results could be related to similar studies involving other age groups.

Only English language articles or articles with an English-language summary are abstracted. Due to the significant number of non-English articles encountered, a second section lists references for articles that did not provide an English summary.

Without doubt we have missed or overlooked many relevant papers, and our apologies are extended to the omitted authors. If it becomes possible, we would like to consider a follow-up report that would include overlooked articles and translations of pertinent non-English language articles. The authors would appreciate receiving reprints of articles that should be included in the proposed follow-up report.

The printing format (tear-out index cards) reflects our emphasis on producing a working document that is immediately amenable to most filing or reference systems.

## ACKNOWLEDGMENTS

The development of an abstracted bibliography has been greatly facilitated by the direct assistance of an excellent library staff. The authors gratefully acknowledge the contributions to this report of our superior NAMI/NAMRL library staff: Ruth Rogers, Head Librarian; Ann Chalk; Margaret Fowler; and Gayle Bell.

We would also like to acknowledge the invaluable assistance provided by Barbara Martin who edited and typed the manuscript.

SECTION A

Bibliography Abstracts (English Language)

Acquisition Form

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R

AUTHOR: Alexander, A. B.

1

TITLE: Vertigo in children

REFERENCE: Brit. Med. J., 1977, 2, 1356.

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: Clinical observation

FINDINGS:

"Children do not often complain of certain labyrinthine stimulations because they enjoy them...."

"...this component of enjoyment (it ends with puberty)..."

COMMENT: Reply to previous note. See Brit. Med. J., 1977, 2, 1173.

INDEX: Vertigo/dizziness

100

AUTHOR: Arslan, M.

2

TITLE: The senescence of the vestibular apparatus

REFERENCE: Pract. Oto-Rhino-Laryng., 1957, 19, 475-483.

SUBJECTS (Number-age): 50 Ss (Range 49-84)

EXPERIMENTAL PROCEDURES:

Caloric (N = 50)

Rotation (N = 50) - Nystagmus

FINDINGS:

Relative to Arslan's concept of normality, within the age range 49-84 years, VOR's of Ss tested were:

Caloric - 30/50 decreased vestibular reflexes

6/50 increased      "      "

14/50 normal      "      "

---

Rotation 5/10 hypoexcitability  
5/10 normal reflexes

INDEX: Caloric, rotation

AUTHOR: Bakwin, H.

3

TITLE: Motion sickness in children

REFERENCE: J. Pediatr., 1949, 35, 390-393

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: N/A - Review

FINDINGS:

1. "Car sickness is more common in children than in adults. It makes its appearance during the second or third year of life but, contrary to general opinion, it does occur occasionally in infants."

2. "The condition is usually hereditary, occurring in several members of the same family."

3. "Seasickness and airsickness are less common in children than in adults."

4. "A small proportion of the population (about 5 per cent) is severely affected when exposed to the sea and seems never to become acclimatized."

5. "Motion sickness usually persists throughout life but it tends to improve as the child grows older."

COMMENT: Review of general observations

INDEX: Motion sickness, review

AUTHORS: Barber, H. O., and Wright, G.

4

TITLE: Positional nystagmus in normals

REFERENCE: Adv. Oto-Rhino-Laryng., 1973, 19, 276-285.

SUBJECTS (Number-age): 114 Ss      1st group      11-45 yrs. (N = 60)  
    2d group      46-75 yrs. (N = 54)

EXPERIMENTAL PROCEDURES: Positional nystagmus testing

FINDINGS:

No statistical difference in positional nystagmus between the two age groups.

COMMENT: High incidence (only 20/112 had no positional nystagmus) of positional nystagmus in normals

INDEX: Positional

AUTHOR: Basser, L. S.

5

TITLE: Benign paroxysmal vertigo of childhood

REFERENCE: Brain, 1964, 87, 141-152.

SUBJECTS (Number-age): 17 cases. Ages not indicated

EXPERIMENTAL PROCEDURES: Clinical review

FINDINGS:

1. Onset of childhood benign paroxysmal vertigo starting before four years of age.

2. Benign paroxysmal vertigo of childhood is not uncommon.

COMMENT: Condition is self-limiting and will eventually disappear.

INDEX: Review, vertigo

AUTHOR: Beddoe, G. M.

6

TITLE: Vertigo in childhood

REFERENCE: Otolaryngologic Clinics of North America, 1977, 10, 139-144

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A - Review

FINDINGS: General clinical discussion of vestibular disorders in childhood

COMMENT:

INDEX: Review

AUTHOR: Bergstedt, M.

7

TITLE: Stepwise change of amplitude and frequency of vestibular nystagmus

REFERENCE: Adv. Oto-Rhino-Laryng., 1973, 19, 304-310

SUBJECTS (Number-age): 300 normals (test subjects); 300 patients  
Ages not indicated.

EXPERIMENTAL PROCEDURES: Caloric test, rotation test

FINDINGS:

Describes Bergstedt's observation that for vestibular and spontaneous nystagmus, eye speed is held constant by a modulation of frequency and amplitude. Change in one parameter (frequency or amplitude) is related to a compensatory change in the other. This stepwise modulation "...seems to be part of a normal mechanism for the regulation of nystagmus."

COMMENT: No age discrimination

INDEX: Caloric, rotation

AUTHOR: Bergstrom, B.

8

TITLE: Morphology of the vestibular nerve. II. The number of myelinated vestibular nerve fibers in man at various ages

REFERENCE: Acta otolaryng., 1973, 76, 173-179

SUBJECTS (Number-age): 11 Ss (Birth - 85 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. "...a considerable reduction of the number of vestibular nerve fibers with increasing age."
2. 37% reduction
3. Reduction usually begins around 40 yrs. of age.

COMMENT: Results seem to contradict Rasmussen (1940) and Naufal and Schuknecht (1972).

INDEX: Histology

AUTHOR: Bergstrom, B.

TITLE: Morphology of the vestibular nerve. III. Analysis of the calibers of the myelinated vestibular nerve fibers in man at various ages

REFERENCE: Acta Otolaryng. (Stockh.), 1973, 76, 331-338

SUBJECTS (Number-age): 9 Ss One newborn, 4 adults (22-53 yrs.), 4 old persons (78-85 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

Fibers (preganglionic vestibular nerve) are small in infants and there is a gradual growth of the myelin sheath until adulthood - then with advancing age the number of fibers decreases and this decrease is especially evident in larger fibers (possible differential effect on canals versus otoliths).

Ampullary nerves have more thick fibers than macular nerves (also more fibers).

COMMENT:

INDEX: Histology

AUTHOR: Bergstrom B.

TITLE: Numerical analysis of the vestibular nerve in man

REFERENCE: Upsala J. Med. Sci., 1972, 77, 205-207.

SUBJECTS: 11 individuals (Birth to 85 yrs.)

EXPERIMENTAL PROCEDURES: Histology of myelinated fibers in vestibular nerve.

FINDINGS:

1. "...there is a clear and statistically significant reduction in number of fibers occurring with increasing age."

2. "The reduction averages 40% in the old age group."

COMMENT: Similar to other articles in this series, showing significant loss of afferents (and possibly efferents) in the vestibular nerve.

INDEX: Histology

AUTHORS: Best, C. H., Sellers, E. A., and Stephenson, N. R. 11

TITLE: Seasickness - Animal experiments

REFERENCE: In: Proceedings of the Conference on Motion Sickness, National Research Council of Canada, Rept. No. C735, Appendix A, August 28, 1942

SUBJECTS (Number-age): 5 dogs (2 wks. old)

EXPERIMENTAL PROCEDURES: Parallel swing

FINDINGS:

"Sjoberg (6) mentions in his monography (sic) on seasickness that 'young animals do not react by vomiting but appear to be immune to the movements.' In order to verify this finding five pups two weeks old, and from the same litter, were placed in the swing and subjected to the motion for an hour.

"All of the pups appeared to be quite unconcerned by the swinging and slept most of the time. However, slight salivation was noticed in two of the pups when they were removed from the cage. Although our experiment is not a good one owing to the small number of puppies used, it is probable that puppies are not as susceptible to motion sickness as older dogs are."

COMMENT:

INDEX: Motion sickness (animals)

AUTHOR: F. O. Black 12

TITLE: Vestibular causes of vertigo

REFERENCE: Geriatrics, 1975, 30, 123-132

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A - Review (clinical)

FINDINGS:

1. "The older the patient is at onset, the poorer is the prognosis for complete resolution of altered balance reflexes and sensations."
2. "...proportional to their physiologic age."
3. Final status depends upon
  - a) degree of destruction
  - b) patient's age.

COMMENT: Plasticity of vestibular system decreases with age.

INDEX: Review

AUTHORS: Blanck, A., Hard, E., and Larsson, K.

13

TITLE: Ontogenetic development of orienting behavior in the rat

REFERENCE: J. Comp. Physiol. Psychol., 1967, 63, 327-328

SUBJECTS (Number-age): 204 infant rats

EXPERIMENTAL PROCEDURES: Observation

FINDINGS:

"Three stages in development of orienting behavior can be distinguished. A first stage, ending about Day 5, was characterized by movements of head and forelegs. In the second stage, ending at Day 10, all legs were involved in the movements, the behavior was dominated by pivoting, and S moved around, but in a very restricted area. In the third stage, the earlier response patterns were superseded by walking."

COMMENT:

INDEX: General (animals)

AUTHORS: Brandt, T., Wenzel, D., and Dichgans, J.

14

TITLE: [Visual stabilization of f stance in infants: A sign of maturity]

REFERENCE: Arch. fur Psychiat. Nervenkr., 1976, 223, 1-13

SUBJECTS (Number-age): N not indicated (6 months to 16 yrs.)

EXPERIMENTAL PROCEDURES: Optokinetic - stance

FINDINGS:

"Scalings of the reactions in children between 6 months and 16 years revealed three phases of development: (1) 6-12-month-old-babies show none or very little optokinetic disturbance of their newly acquired ability to sit. With the development of upright stance and gait, optokinetic influences become increasingly important. (2) Children between the age of 2-5 show a marked dependence of postural stability on vision. In them, the disturbing optokinetic stimulus leads to a marked ipsilateral postural deviation or irresistible fall. (3) From 5 to 15 years of age, visual effects on postural balance slowly decrease to their final strength in adulthood - moderate head and body tilt - in response to the rotating stimulus."

COMMENT: English summary only

INDEX: Optokinetic, stability/ataxia

AUTHORS: Brookler, K. H., and Pulec, J. L.

15

TITLE: Computer analysis of electronystagmography records

REFERENCE: Trans. Amer. Acad. Ophthalmol. Otolaryngol., 1970, 74, 563-575.

SUBJECTS (Number-age): 4990 Ss Range 5 to 94 (10-yr. groupings)

EXPERIMENTAL PROCEDURES: Caloric test

FINDINGS:

Warm water (44° C) - no change with increasing age

Cool water (30° C) - small but significant decrease with increasing patient age ( $p < .001$ )

COMMENT: Several other vestibular tests (spontaneous nystagmus and positional) used but data not reported by age for other than caloric.

INDEX: Caloric

AUTHOR: Brooks, M.

16

TITLE: Seasickness

REFERENCE: U. S. Navy Medical Bulletin, 1939, 37, 469-480

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A - Review

FINDINGS:

"No one is immune and no age is exempt. Infants under 2 years are seldom affected. Children under 12 years seldom suffer severely. The elderly, as do some heavy drinkers, stand sea travel rather well."

COMMENT:

INDEX: Motion sickness, review

AUTHOR: Brown, J. S.

17

TITLE: The clinical applications of the early development of the human ear

REFERENCE: Trans. Amer. Laryng., Rhinol., Otol. Soc., 1964, 292-303

SUBJECTS (Number-age): 148 cases (birth)

EXPERIMENTAL PROCEDURES: Questionnaire concerning unusual procedures during delivery

FINDINGS:

"...the inner ear of the fetus may have a function in utero which may pre-determine the position of the fetus, not only as it rests in the uterus, but also as to how it will present at the time of birth."

COMMENT: General clinically oriented discussion

INDEX: General, review

AUTHORS: Bruner, A., and Norris, T. W.

18

TITLE: Age-related changes in caloric nystagmus

REFERENCE: Acta Otolaryng., 1971, Supplement 282.

SUBJECTS (Number-age): 293 Ss Range 20 to 88 yrs. Groupings by 10-year intervals.

EXPERIMENTAL PROCEDURES:

Caloric test

Bekesy hearing test

FINDINGS:

1. All nystagmus parameters increased responsivity into the 60's followed by decline.

2. Spontaneous or positional nystagmus did not vary with age.

3. Authors propose two mechanisms to account for stronger reaction to warm stimuli in aged Ss. "Age increments in nystagmus were more pronounced for warm stimuli than for cold."

COMMENT: All Ss referred for complaints of dizziness. Remaining Ss from total sample of 514 excluded.

INDEX: Caloric, review

AUTHOR: Buch, N. H.

19

TITLE: The inner ear of newborn infants

REFERENCE: J. Laryng. Otol., 1966, 80, 765-777

SUBJECTS: (Number-age): 73 newborn infants who died shortly after birth

EXPERIMENTAL PROCEDURES: Temporal bone histology

FINDINGS:

Increased vascular fragility in premature infants (as related to inner ear)

COMMENT: Emphasis on cochlea

INDEX: Histology

AUTHOR: Busic, S. N.

20

TITLE: Vertigo in children

REFERENCE: Pediat. Ann., 1976, 5, 478-481

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A - Review

FINDINGS:

1. Short, clinically oriented article.
2. General discussion on testing and evaluating vestibular problems in children.

COMMENT:

INDEX: Review

AUTHORS: Camarda, V., and Lumia, V.

21

TITLE: Sulla funzione vestibolare dell'uomo in età senile

REFERENCE: Giornale di Gerontologia, 1959, 7, 525-531

SUBJECTS (Number-age): Group aged 70 to 92 yrs. N not indicated.

EXPERIMENTAL PROCEDURES: Rotatio test

FINDINGS:

Thresholds to rotary stimuli (1.4°/s to 9°/s) higher in aged (70-92 yrs.) than for young subjects. This may "...indicate a loss of vestibular excitability."

COMMENT: English summary only

INDEX: Rotation

AUTHOR: Casler, L.

22

TITLE: Supplementary auditory and vestibular stimulation: Effects on institutionalized infants

REFERENCE: J. Exp. Child Psychol., 1975, 19, 456-463

SUBJECTS (Number-age): 156 full-term infants (12 days to 6 weeks)

EXPERIMENTAL PROCEDURES:

Group 1 30 min/day supplementary vestibular stimulation

Group 2 30 min/day supplementary vestibular and verbal stimulation

Group 3 Control - untreated

FINDINGS:

"Group comparisons revealed no significant treatment effects."

COMMENT: Assessed at various intervals through age of 27 months with Gesell Developmental Schedules

INDEX: General

AUTHOR: Charles, C. M.

23

TITLE: Dizziness and vertigo

REFERENCE: Geriatrics, 1956, 11, 110-112

SUBJECTS (Number-age); Not indicated

EXPERIMENTAL PROCEDURES: Not indicated

FINDINGS:

General review.

COMMENT:

General clinical comments on diagnosis and treatment of dizziness

INDEX: Vertigo/dizziness

AUTHOR: Chladek, V.

24

TITLE: Changes in the vestibular apparatus in old age

REFERENCE: Casopis Lekaru Ceskych. (Czechoslovakia), 1966, 105, 15-18

SUBJECTS (Number-age): 51 Ss (60-75 yrs. old)

EXPERIMENTAL PROCEDURES:

Rotation test

Caloric test

FINDINGS:

"The suprathreshold post-rotation excitability was frequently raised, the caloric reaction was, however, reduced."

COMMENT: Relation of presbycusis to vestibular changes

INDEX: Rotation, caloric

AUTHORS: Chinn, H. I., Handford, S. W., Smith, P. K., Cone, T. E., Redford, R. F., Maloney, J. V., and Smythe, C. M.

TITLE: Evaluation of some drugs in seasickness

REFERENCE: J. Pharmacol. and Exp. Therapeut., 1953, 108, 69-79

SUBJECTS (Number-age): 5,219 Ss (17 yrs. to 40+), all males

EXPERIMENTAL PROCEDURES:

Exposure to seasickness

FINDINGS:

"It was reported in a previous study (Chinn et al., 1952) that the susceptibility to motion decreased with age, at least for the age groups 17 through 39. The present data demonstrate this trend convincingly."

COMMENT:

Age groups: 17-19, 20-24, 25-29, 30-39, 40 and over

INDEX: Motion sickness

AUTHORS: Chinn, H. I., and Smith, P. K.

TITLE: Motion sickness

REFERENCE: Pharmacol. Rev., 1955, 7, 33-82

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A - Review

FINDINGS:

1. "The resistance of young children (under age 2) to motion has been attested by numerous workers (Tyler & Bard, 1949), although no controlled study has ever been made on this matter."

2. "Certainly, there is no question that the susceptibility to seasickness drops sharply between young adulthood and middle age."

COMMENT:

INDEX: Motion sickness, review

AUTHORS: Clark, D. L., Kreutzberg, J. R., and Chee, F. K. W.

27

TITLE: Vestibular stimulation influence on motor development in infants

REFERENCE: Science, 1977, 196, 1228-1229

SUBJECTS (Number-age): 26 Ss (3-13 months)

EXPERIMENTAL PROCEDURES:

Testing - reflex tests

Treatment - rotation

FINDINGS:

1. "...exposure to vestibular stimulation accelerates motor development in infants."
2. Reduction in muscle tonus during passive rotation
3. Appeared to enjoy rotation

COMMENT:

INDEX: General, rotation

AUTHORS: Clement, par P.A.R.H.E.M., Van der Laan, F. L., and Oosterveld, W. J.

28

TITLE: L'influence de l'age sur la Fonction vestibulaire

REFERENCE: Acta Oto-Rhino-Laryng. (Belgica), 1975, 29, 163-172

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES:

Caloric test

Rotation test

FINDINGS:

SUMMARY. "Regular changes in vestibular responsivity as a function of age are demonstrated with the maximum speed of the slow phase of caloric nystagmus. The clinical implication of this is that, when doing caloric tests, one should not switch for no reason (sic) from a once accepted temperature sequence, otherwise comparison with other tests becomes impossible."

"In rotation tests the best reactions are found in young people. The amplitude is a good parameter to detect age-factors in rotatory nystagmus."

COMMENT: English summary only

INDEX: Caloric, rotation.

AUTHORS: Comalli, P. E., Jr., Wapner, S., and Werner, H.

29

TITLE: Perception of verticality in middle and old age

REFERENCE: J. Psychol., 1959, 47, 259-266

SUBJECTS (Number-age): 75 Ss (men) (20-50, 65-80 yrs.)

EXPERIMENTAL PROCEDURES: Adjusting luminescent rod (S tilted)

FINDINGS:

(Include some results from previous study on subjects ranging from 6 to 20 yrs.)

1. 6-15 yrs. - apparent vertical is located to the same side as body tilt.  
16-50 yrs - opposite side.  
65-80 yrs. - same side.
2. Effect of starting rod position was greatest at the youngest age level  
(No changes beyond 19 yrs.)
3. Three conditions of body tilt: 30° left tilt; erect; 30° right tilt

COMMENT: Young and old - egocentric organization of space

INDEX: Visual tilt

AUTHORS: Correia, M. J., Ireland, D. J., Singer, L. A., Eden, A. R.,  
Griffiths, C. M., and Price, R. B.

30

TITLE: Evaluation of vestibular function using sinusodial (sic) oscillation produced during the damped torsion swing test

REFERENCE: The Proceedings of a Space Motion Sickness Symposium, Homick, J. L. (Ed.), Nov. 1978, Johnson Space Center, Houston

SUBJECTS (Number - age): 95 Ss. Ten-yr. age groupings 0 through 60, plus a 61 to 80 combined group

EXPERIMENTAL PROCEDURES: Damped torsion swing test

FINDINGS:

Trend - older groups have higher maximum number of beats at maximum acceleration ( $18^{\circ}/sec^2$ ) and also a higher slope across all accelerations for these age groups.

"...only the extreme age groups (0-10 yrs. and 61-80 yrs.) are statistically significantly different from the remaining ages grouped in decades."

COMMENT:

INDEX: Torsion swing test

AUTHOR: Corso, J. F.

31

TITLE: The sensory effects of aging in man

REFERENCE: Scientia, 1968, 103, 362-393

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: Review

FINDINGS:

1. No mention of vestibular functioning.
2. Review sections on vision, audition, gustation, olfaction, pain, touch, and vibration,

COMMENT:

INDEX: Review

AUTHORS: Davies, A.D.M., and Leytham, G.W.H.

32

TITLE: Perception of verticality in adult life

REFERENCE: Brit. J. Psychol., 1964, 55, 315-320

SUBJECTS (Number-age): 96 Ss (20-29, 30-39, 40-49, 50-59, 60-69, 70-79),  
male and female

EXPERIMENTAL PROCEDURES:

Moving a luminescent rod to vertical while at various body tilts (upright or tilted  $\pm 30^\circ$ )

FINDINGS:

"The subjects, unlike those of Comalli et al., located the vertical to the side opposite to the body tilt throughout the 20-79 age range."

COMMENT:

Opposed to findings by Comalli et al. that older subjects located vertical to the same side as body tilt.

INDEX: Visual tilt

AUTHOR: Desnoes, P. H.  
TITLE: Seasickness  
REFERENCE: JAMA, 1926, 86, 319-324  
SUBJECTS (Number-age): N/A  
EXPERIMENTAL PROCEDURES: N/A Review

33

FINDINGS:

"In general, those in the extremes of life (infants or aged persons) suffer least; for the perceptive faculties of the former are immature and undeveloped and of the latter have frequently begun to degenerate."

COMMENT:

INDEX: Review, motion sickness

AUTHOR: Despons, J-L.  
TITLE: A propos de l'electronystagmographie chez l'enfant  
(About electronystagmography on the child)  
REFERENCE: Revue de Laryngologie, 1966, 87, 985-991  
SUBJECTS (Number-age): Not indicated  
EXPERIMENTAL PROCEDURES:

Rotation test  
Caloric test

FINDINGS:

"...physiological maturation of the labyrinth,..."  
Detailed findings not indicated in summary.

COMMENT: English summary only

INDEX: Rotation, caloric

34

AUTHORS: Diamond, S. G., Markham, C. H., Simpson, N. E., and Curthoys, I. S.

TITLE: Binocular counterrolling in humans during dynamic rotation

REFERENCE: Acta otolaryng. (Stockh.), 1979, 87, 490-498

SUBJECTS (Number-age): 7 Ss 18 to 66 yrs.

EXPERIMENTAL PROCEDURES:

Counterrolling during passive whole body rotation

FINDINGS:

"Amount of counterrolling was inversely correlated with age."

Downward eye counterrolled more than upward eye.

COMMENT:

INDEX: Counterroll

AUTHORS: Droller, H., and Pemberton, J.

TITLE: Vertigo in a random sample of elderly people living in their homes

REFERENCE: J. Laryngol., 1953, 67, 609-694

SUBJECTS (Number-age): 476 Ss (60-64, 65-69, 70-74, 75-79, 80+)

EXPERIMENTAL PROCEDURES:

Interview

FINDINGS:

"...frequent attacks of vertigo became more common with advancing age. Women had a higher incidence of vertigo than men at all ages."

"It is probable that the bulk of our subjects who suffered from vertigo had considerable arteriosclerotic damage to the labyrinth."

COMMENT:

INDEX: Vertigo/dizziness

AUTHORS: Droller, H., Pemberton, J., Roseman, C., and Grout, J.L.A.

TITLE: High blood pressure in the elderly

REFERENCE: Brit. Med. J., 1952, 2, 968-970

SUBJECTS (Number-age): 476 Ss (60-64, 65-69, 70-74, 75+ yrs.)

EXPERIMENTAL PROCEDURES: Interview and blood pressure check

FINDINGS:

1. 29% women, 14% men complained of frequent or continuous vertigo.
2. "It shows that there was no relation between the presence of vertigo and the height of the systolic or diastolic blood pressure."

COMMENT:

INDEX: Vertigo/dizziness

AUTHOR: Edwards, A. S.

TITLE: The measurement of static ataxia

REFERENCE: Amer. J. Psychol., 1942, 55, 171-188

SUBJECTS (Number-age): 1400+ Several experiments

EXPERIMENTAL PROCEDURES: Ataxia tests

FINDINGS:

"The study of more than 1400 Ss show a clearly increasing steadiness in standing erect, both with eyes open and with eyes closed, as age increases from three to about twenty years.

"Although there is some increase in sway for some of the oldest Ss, there is, on the average, no great increase in static ataxia in Ss with advancing age if uncomplicated by other factors.

"At the early ages, and for the feeble-minded and insane especially, great variability is found. The extremes of high and low are also great."

COMMENT:

INDEX: Stability/ataxia

AUTHORS: Engstrom, H., Ades, H. W., Engstrom, B., Gilchrist, D., and Bourne, G.

TITLE: Structural changes in the vestibular epithelia in elderly monkeys and humans

REFERENCE: Adv. Oto-Rhino-Laryng., 1977, 22, 93-110

SUBJECTS (Number-age): 5 Rhesus monkeys

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

Aging:

1. Supporting cell degeneration in vestibular sensory organs extensive with age
2. Type I cells modified with age much more than Type II cells

COMMENT:

INDEX: Histology (animal)

AUTHORS: Engstrom, H., Bergstrom, B., and Rosenhall, U.

TITLE: Vestibular sensory epithelia

REFERENCE: Arch. Otolaryng., 1974, 100, 411-418

SUBJECTS (Number-age): Human, guinea pig, and squirrel monkey (no details)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. "...there is an age-related progressive reduction in the number of both sensory cells and nerve fibers over the age of 40 years."
2. Reduction - in ampullary crest, 40%  
in maculae, 20%
3. Nerve fibers become thinner at old age.

COMMENT:

Short review type article of authors' work.  
Clearly denotes 40 years as critical age.  
Individual differences great.  
(Canals vs. otoliths)

INDEX: Histology, review (human,animal)

AUTHORS: Eviatar, L., and Eviatar, A.

41

TITLE: Neurovestibular examination of infants and children

REFERENCE: Adv. Oto-Rhino-Laryng., 1978, 23, 169-191

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A      Review (Postural-vestibular reflexes)

FINDINGS: General review

COMMENT: Article details a host of vestibular function tests used in young and developing infants.

INDEX: General, review

AUTHORS: Eviatar, L., and Eviatar, A.

42

TITLE: Vertigo in children: Differential diagnosis and treatment

REFERENCE: Pediatrics, 1977, 59, 833, 838

SUBJECTS (Number-age): 50 children (pediatric patients - ages not reported)

EXPERIMENTAL PROCEDURES:

Positional test

Torsion swing

Caloric (3 yrs. +)

EEG

FINDINGS:

1. "...a high incidence of 'central vertigo' (42 of 50) in children."
2. Vertiginous seizures 27/50
3. 2/50 had benign paroxysmal vertigo.

COMMENT:

All Ss were patients complaining of "dizziness."

Discussion of general clinical vestibular evaluation in children

INDEX: Positional, torsion swing, caloric

AUTHORS: Eviatar, L., Eviatar, A., and Naray, I.

43

TITLE: Maturation of neurovestibular responses in infants

REFERENCE: Developmental Medicine and Child Neurology, 1974, 16, 436-46

SUBJECTS (Number-age): 121 infants (within 10 to 75 days of birth)

EXPERIMENTAL PROCEDURES: Torsion swing test; caloric test

FINDINGS:

1. TST 83% of AGA infants had nystagmus, 24% of SGA
2. Caloric 69% of AGA infants had nystagmus, 26% of SGA
3. "None of the pre-term babies showed nystagmus in response to vestibular stimulation within 10 to 75 days of birth."
4. "Some of the babies tested within 10 to 75 days of birth showed only a unilateral response, but when tested at a later date they had developed bilateral responses."

COMMENT:

AGA = appropriate birth weight for gestational age

SGA = small for gestational age

LGA = large for gestational age

Full term = 38 to 42 wks. gestation

Pre-term = 34 to 37 wks. gestation

INDEX: Torsion swing, caloric

AUTHORS: Eviatar, A., and Wassertheil, S.

44

TITLE: The clinical significance of 'directional preponderance' concluded by electronystagmography

REFERENCE: J. Laryngol. Otol., 1971, 85, 355-367

SUBJECTS (Number-age): 1,101 patients (5-80 yrs.) (1-20, 21-30, 31-50, 51-70, 71-80)

EXPERIMENTAL PROCEDURES:

Caloric test

Positional test

FINDINGS:

1. In young patients (: 30-50 yrs.) directional preponderance is indicative of CNS disease.
2. "...directional preponderance becomes meaningful when the age of the patient is considered."

COMMENT:

INDEX: Caloric, positional

AUTHORS: Falbe-Hansen, J., Andreassen, J. C., and Falbe-Hansen, J., Jr. 45

TITLE: Homogenous deposits in the membranous semicircular canals

REFERENCE: Arch. Otolaryngol., 1967, 85, 359-364

SUBJECTS (Number-age):

23 Meniere patients (from 10 yrs. to 80+ yrs.)  
23 "normals"

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. "The appearances, however, gave the impression that the thickening of the membrana propria increased with advancing age."
2. "In addition, we have demonstrated, in relatively large autopsy and operation series, both comprising persons under 30 years of age, that the homogenous masses consist partially of acid mucopolysaccharides, that they are not present in the young age groups, and that they appear to increase in size with advancing age."
3. "Apart from the youngest age groups both series showed pronounced homogenous deposits in the membrana propria increasing in thickness with advancing age (after the age of 20) and containing acid mucopolysaccharides."

COMMENT:

INDEX: Histology

AUTHORS: Fish, B., and Dixon, W. J. 46

TITLE: Vestibular hyporeactivity in infants at risk for schizophrenia

REFERENCE: Arch. Gen. Psychiat., 1978, 35, 963-971

SUBJECTS (Number-age): 10 Ss (birth to 2 yrs.)

EXPERIMENTAL PROCEDURES: Caloric test (air)

FINDINGS:

1. "Transiently decreased vestibular responses coincided with several developmental disorders that were related to psychopathology at 10 years."
2. An indication of disrupted CNS integration

COMMENT:

1. Nystagmus was observed (no ENG) in lighted room.
2. Attempt to analyze data according to arousal level

INDEX: Caloric

AUTHORS: Fregly, A. R., and Graybiel, A.

47

TITLE: An ataxia test battery not requiring rails

REFERENCE: Aerospace Med., 1968, 39, 277-282

SUBJECTS (Number-age):

2,077 males                    Age groupings: 17-42, 18-29, 30-49, 43-50, 51-53,  
369 females                    50-70

EXPERIMENTAL PROCEDURES:

Ataxia test - floor battery

FINDINGS:

"Performance capabilities begin to decline in males, apparently at about 43 and in females, apparently, at about age 30."

COMMENT:

INDEX: Stability/ataxia

AUTHORS: Fregly, A. R., Smith, M. J., and Graybiel, A.

48

TITLE: Revised normative standards of performance of men on a quantitative ataxia test battery

REFERENCE: Acta Otolaryng. (Stockh.), 1973, 75, 10-16

SUBJECTS (Number-age):

1,055 Ss (16 to 60 yrs.)    Age groupings: 16-30, 31-40, 41-45, 46-50, 51-60

EXPERIMENTAL PROCEDURES: Ataxia test (combined floor-rail battery)

FINDINGS:

"...aging negatively influences ataxia test battery performance skills several years earlier than previously reported...within the 30-40 rather than 43-50 year age range "

Data show a dramatic decline in postural equilibrium as indicated by these ataxia tests.

COMMENT:

INDEX: Stability/ataxia

AUTHOR: Gaibsky, A.

49

TITLE: Vestibular nystagmus in new-born infants

REFERENCE: Acta Otolaryng. (Stockh.), 1927, 11, 411-430

SUBJECTS (Number-age): Review (Fetus- newborn - adult)

EXPERIMENTAL PROCEDURES: Review

Rotation test

Caloric test

OKN

FINDINGS:

1. All canals react to rotation immediately after birth.
2. New-borns (a) strong slow component (head and eyes)  
(b) weak or absent fast component  
(c) shorter duration
3. "Optical nystagmus cannot be produced in new-born infants by a disc striped black and white rotating before their eyes."

COMMENT:

INDEX: Rotation, caloric, optokinetic

AUTHORS: Gramowski, K. -H., and Unger, E.

50

TITLE: Experimentelle vestibulare habituation bei jungen und alteren  
versuchspersonen

REFERENCE: Z. Laryng. Rhinol. Otol. INRE Gerenzgebiete., 1969, 3, 207-213

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: Not indicated

FINDINGS:

Summary

"The reduction in the response in experimental vestibular habituation is much more marked in duration and extent with older people than young subjects. It is suggested that the greater loss of reaction rates in older subjects is due to a reduction or loss of normal habituation. The small reduction of the reaction rates in younger persons, on the other hand, is evidence of an already present habituation (pre-habituation)."

COMMENT: English summary only

INDEX: General

AUTHORS: Gramowski, K. -H., and Unger, E.

51

TITLE: Über die altersabhängigkeit thermischer labyrinth reaktionen

REFERENCE: Z. Laryng., Rhinol., Otol., and IHRE Gerenzgebiete., 1973, 52,  
541-547

SUBJECTS (Number-age):

2 groups      young group  $\bar{x}$  19 yrs.  
                  older group  $\bar{x}$  65 yrs.

EXPERIMENTAL PROCEDURES: Caloric test

FINDINGS:

1. "No difference could be shown between the two groups measuring duration, total number of beats and total amplitude, in relation to borderline values for unilateral hypoexcitability and directional preponderance of the experimental nystagmus."
2. "...older normal subjects tend to have more marked reactions after the warm stimulus [significant]."
3. "The hyperreactivity of the labyrinth in the older age group is attributed to a decrease in the central vestibular suppressive mechanism..."

COMMENT: English summary only

INDEX: Caloric

AUTHORS: Graybiel, A., and Fregly, A. R.

52

TITLE: A new quantitative ataxia test battery

REFERENCE: Acta Otolaryng. (Stockh.), 1966, 61, 292-312

SUBJECTS (Number-age):

Long version: 550 males, 158 females, 11 L.D.'s  
Short version: 828 males, 99 females, 10, L.D.'s  
Otoneurologic patients: 17 males, 15 females

EXPERIMENTAL PROCEDURES: Ataxia test (rail)

FINDINGS:

Long version: "The two standing tests appear to be more sensitive to age increases than is the walk heel-to-toe test. In males, standing test performances appear to decline significantly as early as age 43, and walk H/T performance appears to decline significantly at the later age of 54."

Short version: "In the males tested, performance declined significantly in about the age range of 43 to 53 years."

COMMENT:

long version had only small N's over 43 years old.  
Short version had only small N's over 50 years old.

INDEX: Stability/ataxia

AUTHOR: Groen, J. J.

53

TITLE: Postnatal changes in vestibular reactions

REFERENCE: Acta Otolaryng. (Stockh.), 1963, 56, 390-397

SUBJECTS (Number-age): One infant observed at 9, 16, 16, and 82 days after birth; 2 dogs

EXPERIMENTAL PROCEDURES: Rotational test - nystagmus cupulogram

FINDINGS:

Progressive decline of the slope of the nystagmus cupulogram across ~two months for the human infant. (Faster ~ four weeks for dogs.)

COMMENT: Infant was asleep during second and third testing - potential confounding arousal effect.

INDEX: Rotation (human, animal)

AUTHORS: Grohmann, R., and Minnigerode, B.

54

TITLE: Untersuchungen Zur 1. Perrotatrischen Nystagmusperiode

REFERENCE: Acta Otolaryng. (Stockh.), 1967, 64, 338-344

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: Rotation test

FINDINGS:

"The steeper, age-dependent frequency increase and the decrease of the total amplitude during the acceleration nystagmus period - in contrast to the perrotatric fading nystagmus period - leads to the conclusion that the capability to transform an outer physical stimulus into an inner physiological one decreases continually with age."

COMMENT: English summary only

INDEX: Rotation

AUTHOR: Guedry, F. E., Jr.

55

TITLE: Age as a variable in post rotational phenomena

REFERENCE: Joint Project Report No. 19, U. S. Naval School of Aviation  
Medicine, Pensacola, Florida, 1950

SUBJECTS (Number-age): 48 Ss: 24 Ss - 19 to 21 yrs.; 24 Ss - 30+ yrs.

EXPERIMENTAL PROCEDURES: Rotation test (sensation)

FINDINGS: Older group had longer durations of post rotational apparent motion.

COMMENT:

INDEX: Rotation

AUTHORS: Guerrier, Y., Dejean, Y., Basseres, F., and Denise, A. 56

TITLE: Le seuil d'excitabilite vestibulaire de l'enfant normal  
[The threshold of vestibular stimulation in the normal child  
(using the pendular test)]

REFERENCE: Revue de Laryngologie, Otologie, Rhinologie, 1970, 91, 881-899

SUBJECTS (Number-age): 6 wks.- 12 yrs. N not indicated.

EXPERIMENTAL PROCEDURES: Rotation ?

FINDINGS:

6 wks. - no organized nystagmus

60 days+ - no organized nystagmus, with very high threshold

12 yrs. - comparable with adult

COMMENT: English summary only

INDEX: Rotation

AUTHORS: Guerrier, Y., Dejean, Y., Basseres, F., and Denise, A. 57  
TITLE: L'exploration electronystagmographique chez l'enfant  
REFERENCE: J. Francais d'oto-Rhino-Laryngologie Audiophonologie et chirurgie Maxilo-Faciale, 1969, 18, 671-682  
SUBJECTS (Number-age): N not indicated. [2 months to 13 yrs.]  
EXPERIMENTAL PROCEDURES: Rotation ?  
FINDINGS: [Entire English summary]  
"The electronystagmographical exploration in the child is made with the pendular method. Traces regarding children aged 3 months to 13 years are shown. We can witness the progressive modification of traces according to cerebral maturation. The amplitude of periodicity and threshold progressively approximate to the parameters of grown up people."  
"Some cases of peripheral and central otoneurology are shown."  
COMMENT: English summary only  
INDEX: Rotation

AUTHORS: Hard, E., and Larsson, K. 58  
TITLE: Development of air righting in rats  
REFERENCE: Brain, Behavior, and Evolution, 1975, 2, 53-59  
SUBJECTS (Number-age):  
Exp. 1 - 144 rats (13 to 18 days old)  
Exp. 2 - 56 rats  
EXPERIMENTAL PROCEDURES: Air righting  
FINDINGS:  
"The proportion of animals showing complete air righting abruptly increased at 16 days of age indicating maturation of the response at this age."  
COMMENT:  
INDEX: Stability/ataxia (animal)

AUTHOR: Heath, S. R., Jr.

59

TITLE: Rail-walking performance as related to mental age and etiological type among the mentally retarded

REFERENCE: Am. J. Psychol., 1942, 55, 240-247

SUBJECTS (Number-age): 148 boys

EXPERIMENTAL PROCEDURES: Rail-walking

FINDINGS:

1. "In the hereditary group a correlation of  $r = 0.66 \pm .05$  was found between mental age and weighted motor score, while in the non-hereditary group  $r = 0 \pm .07$ ."
2. A comparison of:  
Endogenous (hereditary) - mentally retarded  
Exogenous (non-hereditary) - mentally retarded
3. a) No group differences at 5.5 yrs  
b) From that mental age onward a rapidly increasing difference

COMMENT:

INDEX: Stability/ataxia

AUTHORS: Hellebrandt, F. A., and Braun, G. L.

60

TITLE: The influence of sex and age on the postural sway of man

REFERENCE: Am. J. Physical Anthropology, 1939, 24, 347-360

SUBJECTS (Number-age): 109 Ss (3 yrs. to 86 yrs.)

EXPERIMENTAL PROCEDURES: Stabilimetry

FINDINGS:

"Balance, as demonstrated by a mean centering of the weight over the middle of the base, seems from our data to be uniformly good at all ages. The magnitude of the oscillation of the center of gravity about the geometric center of the base is, however, less constant." There is a "...tendency for the young and the old to be less stable than the young adult and the middle aged subject of both sexes."

COMMENT: Over 50-year-olds were classified as aged.

INDEX: Stability/ataxia

AUTHORS: Hemenway, W. G., and Black, F. O.

61

TITLE: Some thoughts on peripheral vestibular disorders

REFERENCE: Ann. Otol., 1967, 76, 509-518

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: Clinical review

FINDINGS:

"Older people experience difficulties [compensation] directly proportional to their age."

COMMENT: Check list for evaluating peripheral damage

INDEX: Review

AUTHOR: Hill, J.

62

TITLE: The care of the sea-sick

REFERENCE: Brit. Med. J., 1936, 2, 802-807

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A Review

FINDINGS:

"Although infants, having not yet grown to orientation, are immune, I have not found the absolute immunity among older children that is commonly attributed to them. If the disturbing movement begins early in the voyage they are no less susceptible than the average adult; but given a favourable environment, away from sea-sick relatives, they become adapted with amazing rapidity."

COMMENT:

INDEX: Review, motion sickness

AUTHOR: Howlett, J. G.

63

TITLE: Motion sickness

REFERENCE: Canad. Med. Assn. J., 1957, 76, 871-873.

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A Review

FINDINGS:

"Children under two years of age are not susceptible to motion sickness and older subjects are less susceptible than others. In the first group the function of the labyrinth is not well developed, and in the second it is deteriorating."

COMMENT:

INDEX: General, motion sickness

AUTHORS: Johnson, J. E., Jr., and Miguel, J.

64

TITLE: Fine structural changes in the lateral vestibular nucleus of aging rats

REFERENCE: Mechanisms of Ageing and Development, 1974, 3, 203-224

SUBJECTS (Number-age): 12 rats (4 wks, 6-8 wks, 6-8 mos, 18-20 mos.)

EXPERIMENTAL PROCEDURES: Histology - ultrastructural emphasis

FINDINGS:

"In our opinion, the lateral vestibular nucleus of the rat is an excellent model to define aging changes in the nerve cells, as opposed to changes linked to vascular degeneration, which is frequently seen in time-associated degeneration of the human brain."

A host of neuronal changes is described.

COMMENT: Oldest rats (18-20 mos.) - really only middle-aged (authors' comment)

INDEX: Histology (animal)

AUTHOR: Johnsson, L-G.

65

TITLE: Degenerative changes and anomalies of the vestibular system in man

REFERENCE: Laryngoscope, 1971, 81, 1682-1694

SUBJECTS (Number-age): 150 patients (newborn to 97 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

"Almost invariably there were large defects in the layer of statoconia in patients older than 60 years, while in temporal bones from patients under 30 years of age there was, with only a few exceptions, a continuous layer of statoconia covering the entire neuroepithelium. Patients between 30 and 60 years display a varying degree of loss of statoconia."

"...the almost total loss of statoconia seen in the saccule rarely occurs in the utricle."

COMMENT:

INDEX: Histology

AUTHORS: Johnsson, L-G., and Hawkins, J. E.

66

TITLE: Sensory and neural degeneration with aging, as seen in microdissections of the human inner ear

REFERENCE: Ann. Otol., 1972, 81, 179-193

SUBJECTS (Number-age): 150 Ss

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. Loss of otoconia in utricle and saccule (most pronounced) with aging
2. Saccular degeneration

Emphasis mainly on cochlea.

COMMENT: Part of series of reports on this population.

INDEX: Histology

AUTHORS: Johnsson, L-G., and Hawkins, J. E.

67

TITLE: Vascular changes in the human inner ear associated with aging

REFERENCE: Ann. Otol., 1972, 81, 364-376

SUBJECTS (Number-age): 150 Ss (newborn to 97 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. With aging - gradual loss of capillaries
2. Arterioles become narrower and thicker
3. 45-50 yrs. old showing at least some atrophy
4. Devascularization less pronounced in vestibular system as compared to cochlea

COMMENT: Part of series of reports on this population.

INDEX: Histology

AUTHOR: Jorgensen, M. B.

68

TITLE: Changes of aging in the inner ear

REFERENCE: Arch. Otolaryngol., 1961, 74, 56-62

SUBJECTS (Number-age): 25 temporal bones (ages 2 months to 85 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. Loss of ganglion cells in basal cochlea with age
2. Thickening of capillary walls in stria vascularis with age

COMMENT: Geared toward cochlea degeneration and hearing loss

INDEX: Histology

AUTHOR: Kaplan, I.

69

TITLE: Motion sickness on railroads

REFERENCE: Industrial Medicine and Surgery, 1964, 33, 648-651

SUBJECTS (Number-age): 371,261 passengers, of whom 485 had motion sickness

EXPERIMENTAL PROCEDURES: Observation

FINDINGS:

"Also, women reached a peak in the 15 to 19 year groups and the men in the 5 to 15 year groups, with the rate [incidence of motion sickness] for women remaining higher in the 20 to 50 year groups but declining rapidly in a parallel manner to the men after age 50."

COMMENT:

INDEX: Motion sickness

AUTHOR: Kenshalo, D. R., Sr.

70

TITLE: Changes in the vestibular and somesthetic systems as a function of age

REFERENCE: Sensory Systems and Communication in the Elderly (Aging, Vol. 10)  
Ordy, J. M., and Brizzee, K. (Eds.). New York: Raven Press, 1979

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A Review

FINDINGS:

Literature review - only brief mention of vestibular function

COMMENT:

INDEX: Review

AUTHORS: Krejcova, H., Filipova, M., and Krejci, L.

71

TITLE: Vestibulometric evaluation of the caloric reaction in children and in adults

REFERENCE: Electroencephalography and Clinical Neurophysiology, 1975, 39, 441

SUBJECTS (Number-age): 60 Ss: 30 children  $\bar{x}$  age 10  
30 adults  $\bar{x}$  age 28

EXPERIMENTAL PROCEDURES: Caloric test

FINDINGS:

Higher number of nystagmic beats found in children  
Child vs. adult groups, no significant difference in:  
a) duration of nystagmus  
b) latency of first evoked beat

COMMENT: English abstract only

INDEX: Caloric

AUTHORS: Labarba, R. C., and Stewart, A.

72

TITLE: The effects of neonatal vestibular stimulation on adult growth and emotional reactivity in BALB/c mice

REFERENCE: Developmental Psychobiol., 1976, 9, 359-363

SUBJECTS (Number-age): 60 rats, first experiment; 75 rats, second experiment

EXPERIMENTAL PROCEDURES: Rotation

FINDINGS:

"No evidence appeared to suggest that neonatal vestibular stimulation alters either the growth pattern or the ontogenesis of emotional reactivity."

COMMENT:

INDEX: Rotation (animal)

AUTHOR: Langworthy, O. R.

73

TITLE: Development of behavior patterns and myelinization of the nervous system in the human fetus and infant

REFERENCE: Contributions to Embryology, 1933, 24, 1-57

SUBJECTS (Number-age): Opossum, rat, man

EXPERIMENTAL PROCEDURES: Histology - review

FINDINGS:

1. "The first appearance of myelin occurs in the fourth or fifth month of fetal life and is not finished until the time of puberty."
2. "Of the cranial nerves the motor fibers are medullated first and the sensory a little later, with the exception of the acoustic nerve, the vestibular portion of which is myelinated as soon as the motor fibers."
3. "The vestibulo-spinal, reticulo-spinal pathways and the medial longitudinal fasciculus are heavily medullated in the new-born."
4. "Aside from the movements observed in early fetal life there is considerable evidence that tracts in the nervous system become myelinated at the time when they become functional."

COMMENT: "Birth seems to speed up the process of medullation enormously."

INDEX: Histology (human, animal)

AUTHORS: Lapaev, E. V., and Sorochinsky. A. I.

74

TITLE: [About functional state of vestibular analyzer in children of middle and senior school age]

REFERENCE: Zhurnal Ushnykh, Nosovykh, I Gorlorykh (Boleznei), 1977, 6, 32-37

SUBJECTS (Number-age): 61 children (12-16 yrs.)

EXPERIMENTAL PROCEDURES: Rotation test

FINDINGS:

"It is suggested that vestibular analyzer formation takes place at the age of 15-16. Absence of correlation between electronystagmogram dynamics and vestibular stability was shown. The most informative objective index of vestibulo-vegetative stability in juveniles appeared to be vegetative index."

COMMENT: English summary only

INDEX: Rotation

AUTHORS: Lentz, J. M., and Collins, W. E.

TITLE: Motion sickness susceptibility and related behavioral characteristics in men and women

REFERENCE: Aviat. Space Environ. Med., 1977, 48, 316-322

SUBJECTS (Number-age): 1048 Ss (16 to 56 yrs., mean 20.5 yrs.)

EXPERIMENTAL PROCEDURES: Motion sickness history questionnaire

FINDINGS:

A retrospective account of how the general tendency to develop motion sickness may have changed since age 12:

Approx. 40% - no change  
" 30-40% - decrease  
" 5-15% - increase  
" 15% - don't know

COMMENT:

INDEX: Motion sickness

AUTHORS: Liebert, R. S., and Rudel, R. G.

TITLE: Auditory localization and adaptation to body tilt: A developmental study

REFERENCE: Child Devel., 1959, 30, 81-90

SUBJECTS (Number-age): 36 boys, 36 girls (5 to 17 yrs.)

EXPERIMENTAL PROCEDURES: Estimates of midline position by varying an auditory stimulus during tilt conditions (upright,  $\pm 28^\circ$ )

FINDINGS:

"The findings, all of which are significantly related to age, as well as to each other, are: (a) increasing displacement of the estimated auditory midline towards the side opposite body tilt, (b) decrease in "starting position error," and (c) decreasing error of estimating the upright body position following brief suspension in a tilted position."

COMMENT: Auditory localization of midline

INDEX: Visual (auditory) tilt

AUTHOR: Loveless, N. E.

77

TITLE: The development of rotary nystagmus in the cat as a function of age

REFERENCE: Brit. J. Indust. Med., 1960, 17, 46-51

SUBJECTS (Number-age): 35 cats (1 to 41 wks. old)

EXPERIMENTAL PROCEDURES: Examined for oscillation of eyeballs. Cats kept in darkness

FINDINGS:

"The rate at which the amplitude of oscillations increased appeared to be a logarithmic function of the age at which the animal was placed in darkness."

COMMENT: "The onset of miner's nystagmus appears to be related in some way to the age of the worker. It is commonly held to be a disease of middle age, occurring most typically after some 20 to 30 years of underground work."

INDEX: General (animal)

AUTHOR: McGraw, M. B.

78

TITLE: Development of rotary-vestibular reactions of the human infant

REFERENCE: Child Devel., 1941, 12, 17-19

SUBJECTS (Number-age): 67 children (birth to 2 yrs.)

EXPERIMENTAL PROCEDURES: Rotation test

FINDINGS:

1. Three phases of development:

Phase A - with newborn infant - head and eyes deviate in the direction of rotation and remain deviated.

Phase B - infant's face "...may remain forward but the eyes tend to make gross slow horizontal excursions."

Phase C - "...face forward and oscillations of the eyes are fine and rapid."

2. Shift from Phase A to B at end of fourth month

Shift from Phase B to C at approximately seventh month

COMMENT: Observation of eye movements

INDEX: Rotation

AUTHOR: McGraw, M. B.

79

TITLE: Neuro-motor maturation of anti-gravity functions as reflected in the development of a sitting posture.

REFERENCE: J. Genetic Psychol., 1941, 59, 155-175

SUBJECTS (Number-age): 82 infants (birth to 800 days)

EXPERIMENTAL PROCEDURES: Observation (sitting posture)

FINDINGS:

"The newborn infant offers little resistance to gravitational forces, but at same time, usually during the third quarter of the first year of life, he gains the ability not only to resist the force of gravity sufficiently to maintain an erect sitting position but also to overcome the force in order to assume independently a sitting position."

COMMENT: Also daily observations on four infants (longitudinal study)

INDEX: Stability/ataxia

AUTHOR: Meadow, S. R.

80

TITLE: Vestibular nystagmus in infants and the effect of streptomycin in the neonatal period

REFERENCE: Devel. Med. Child Neurol., 1968, 10, 317-321

SUBJECTS (Number-age): Group 1 - 20 babies; Group 2 - 70 babies  
(Group 2 tested at 4 mos. and later at 6 mos.)

EXPERIMENTAL PROCEDURES: Rotation (manual)

FINDINGS:

1. "...babies under the age of four months had post-rotational nystagmus; by the age of seven months they did not."
2. Streptomycin up to 20 mg/kg/day for 4 days did not affect vestibular responses of infants (tested in neonatal period or during first year).

COMMENT: Observation of eye movements

INDEX: Rotation

AUTHOR: Michishita, K.

81

TITLE: Studies of normal vestibular reaction in children

REFERENCE: J. Oto-Rhino-Laryng. Soc. Japan, 1967, 70, 37-60

SUBJECTS (Number-age): Newborn to 15 yrs. N not indicated.

EXPERIMENTAL PROCEDURES: Caloric test, rotational test

FINDINGS:

1. "With regard to duration and frequency of nystagmus very faint reactions were recognized in the children under four years old."

2. "In children ranging in age from 4 years to 6 years, the reaction values increased remarkably to almost the same level as adults. The reaction values of the children between seven and nine years old were the highest of all from 0 to 15 years old."

3. "The children who were above ten years old showed less reaction values in proportion to growth of age until they reached down to the reaction values of adults."

COMMENT: English summary only

INDEX: Caloric, rotation

AUTHORS: Minnigerode, B., and Grohmann, R.

82

TITLE: Untersuchungen zur bestimmung der massgebenden charakteristika des elektronystagmograms gesunder versuchspersonen verschiedenen lebensalters bei rotatorischen beschleunigungsreizen

REFERENCE: Acta Otolaryng. (Stockh.), 1966, 61, 101-112

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: Rotation test

FINDINGS:

Summary does not mention any changes (or lack thereof) across ages.

COMMENT: English summary only

INDEX: Rotation

AUTHORS: Mitchell, T., and Cambon, K.

83

TITLE: Vestibular response in the neonate and infant

REFERENCE: Arch. Otolaryng., 1969, 90, 556-557

SUBJECTS (Number-age): 45 neonates (1-14 days) plus 15 infants (6-16 wks.)

EXPERIMENTAL PROCEDURES: Rotation test and caloric test

FINDINGS:

"...by six weeks, not all normal infants react to vestibular stimulation, but by 8 to 16 weeks the normal infant has a definitely demonstrable response to rotatory and caloric stimuli."

COMMENT:

INDEX: Rotation, caloric

AUTHORS: Morimatsu, M., Hirai, S., Eto, F., and Yoshioka, M.

84

TITLE: Vertigo and dizziness in the elderly

REFERENCE: Japanese J. Geriatrics, 1975, 12, 405-413

SUBJECTS (Number-age): 2,554 patients above age of 49

EXPERIMENTAL PROCEDURES: Questionnaires and routine medical laboratory tests

FINDINGS:

1. 497/2,554 (17.1% male, 21.8% female) had vertigo or dizziness or both.
2. "The most important disorders which caused vertigo or dizziness were arterial hypertension (22.9%), anemia (8.9%), vascular disorders either in the vertebrobasilar system (7.4%) or in the carotid system (7.0%), cervical spondylosis (6.8%) and others."

COMMENT:

INDEX: Vertigo/dizziness

AUTHOR: Mowrer, O. H.

TITLE: "Maturation" vs. "Learning" in the development of vestibular and optokinetic nystagmus

REFERENCE: *J. Genetic Psychol.*, 1936, 48, 383-404

SUBJECTS (Number-age): Pigeons - 10 Ss (Exp. 1); 10 Ss (Exp. 2); 4 Ss (Exp. 3)

EXPERIMENTAL PROCEDURES:

Rotation - Exp. 1

Optokinetic - Exp. 2 and 3

FINDINGS:

1. "It is, however, fairly certain that this type of response [optokinetic nystagmus] is acquired through some sort of learning process rather than through maturation, as appears to be the case in the development of vestibular nystagmus."

2. "...the development of vestibular nystagmus is probably exclusively dependent upon maturational factors."

3. "Visual responses [OKN, etc.] acquired through the functioning of only one eye are thus seen to 'transfer' almost completely to the other, previously 'unseeing' eye."

4. Vestibular nystagmus - mediated via subcortical brainstem

mechanisms - hardwired - less influenced by learning.

Optokinetic nystagmus - mediated via cortical connections.  
more liable to learning influences

COMMENT:

INDEX: Rotation, optokinetic (animal)

AUTHORS: Muleh, G., and Lewitzki, W.

TITLE: Spontaneous and positional nystagmus in healthy persons demonstrated only by electromyogram: Physiological spontaneous nystagmus or "functional scar"?

REFERENCE: *Arch. Oto-Rhino-Laryng.*, 1977, 215, 135-145

SUBJECTS: (Number-age): 102 Ss - 6 age groups between 11 and 70 yrs.  
Groupings by 10-yr. intervals

EXPERIMENTAL PROCEDURES: ENG for spontaneous and positional nystagmus

FINDINGS:

1. Horizontal spontaneous or positional nystagmus a) in 63/102 persons with eyes open in dark; b) in only 2/102 with Frenzel glasses

2. "With open eyes in darkness, the frequency and intensity was the same in all age groups."

3. With closed eyes "the higher the age the more frequent is a spontaneous nystagmus [ $p < .01$ ]...and the larger is its intensity [ $p < .05$ ]."

4. "We share Kornhuber's opinion that the examination with the Frenzel glasses in a dark room, together with the head shaking test and positional test, at the present time represents the best method for differentiating between physiological and pathological spontaneous nystagmus."

COMMENT: Authors' hypothesis: If spontaneous or positional nystagmus was due to preceding damage then it would occur less often in children than in old people.

INDEX: General, positional

AUTHORS: Mulch, G., and Petermann, W. 87

TITLE: Influence of age on results of vestibular function tests: Review of literature and presentation of caloric test results

REFERENCE: Ann. Otol., 1979, 88, Suppl. 56

SUBJECTS (Number-age): 102 Ss - 6 age groups between 11 and 70 yrs.  
Groupings by 10-yr intervals.

EXPERIMENTAL PROCEDURES: Caloric test

FINDINGS:

1. Most intensive reactions (maximum slow phase velocity, maximum amplitude, maximum frequency, and total number of beats) occur in "awake, healthy subjects of middle and late middle-age."

2. "Individuals in their middle years show side differences [ear] to a considerably lesser degree than children and elderly subjects."

COMMENT:

Apparently same subject group as reported in Mulch and Lewitski (1977)

Middle years - 41 to 50 and 51 to 60

Several non-English language articles reviewed.

INDEX: Caloric

AUTHORS: Naufal, P. M., and Schuknecht, H. F. 88

TITLE: Vestibular, facial, and oculomotor neuropathy in diabetes mellitus

REFERENCE: Arch. Otolaryng., 1972, 96, 468-474

SUBJECTS (Number-age): 1 diabetic, 9 controls (8 mos. to 84 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

Mainly aimed at diabetic patient but includes table of normal control subjects (9 Ss) across various ages showing vestibular ganglion cell loss.

Older individuals tend to have fewer ganglion cells, especially in superior division of vestibular nerve.

COMMENT:

INDEX: Histology

AUTHOR: No author

89

TITLE: Vertigo in children

REFERENCE: Brit. Med. J., 1977, 2, 1173

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: Summary of clinical observations

FINDINGS:

"Vertigo is not common in childhood..."

COMMENT:

INDEX: Vertigo/dizziness

AUTHOR: Noble, R. L.

90

TITLE: Treatment of experimental motion sickness in humans

REFERENCE: Canad. J. Research, 1946, 24, 10-22

SUBJECTS (Number-age): 109 Army men and 260 students

EXPERIMENTAL PROCEDURES: Swing (two-pole)

FINDINGS:

"The Army group ... 28 men from 18 to 29 years of age, 60% were susceptible. From 30 to 39 years, of 51 men, 53% vomited. Of 23 men over 40 the incidence was 74%. This last figure suggests that the frequency of swing sickness may increase after 40 years of age."

COMMENT: Above results from control or nonmedicated tests. The experimental conditions involved evaluation of antimotion sickness drugs.

INDEX: Motion sickness

AUTHOR: Oriel, G. H.

91

TITLE: The treatment of sea-sickness

REFERENCE: Lancet, 1927, 2, 811-813

SUBJECTS (Number-age): N/A

EXPERIMENTAL PROCEDURES: N/A - Review, general

FINDINGS:

"There is a well-marked variation in liability to sea-sickness shown by different age-groups, sex-groups, and individuals. Infants under 1 year of both sexes are practically immune from this complaint, possibly owing to the non-development of their sense of balance. An adult could never experience with impunity the tossings and rockings a baby has to endure. Old people of both sexes are also practically immune."

COMMENT:

INDEX: General, motion sickness

AUTHORS: Ornitz, E. M., Brown, M. B., Mason, A., and Putnam, N. H.

92

TITLE: The effect of visual input on post-rotatory nystagmus in normal children

REFERENCE: Acta Otolaryng. (Stockh.), 1974, 77, 418-425

SUBJECTS (Number-age): 25 children (38 to 90 months old)

EXPERIMENTAL PROCEDURES: Rotational test

FINDINGS:

"There were no significant correlations between subject age and nystagmus response under any of the experimental conditions. Similar results obtained for the total number and frequency of beats except that there was a very slight tendency for the total number of beats to increase with age in Condition 6 (complete darkness.)"

COMMENT:

INDEX: Rotational

AUTHORS: Parrad, J., and Cottreau, P.

93

TITLE: Apparition des réactions rotatoires chez le rat nouveau-né  
[Appearance of rotatory reactions in the newborn rat]

REFERENCE: Physiol. and Behav., 1977, 18, 1017-1020

SUBJECTS (Number-age): Rats, newborn

EXPERIMENTAL PROCEDURES: Rotation test

FINDINGS:

Vestibular response to rotatory stimulation increases from first to seventh postnatal day without influence of vision.

COMMENT: English summary only

INDEX: Rotation (animal)

AUTHORS: Pendleton, M. E., Paine, R. S., Bolesworth, A., Coues, P.,  
Glazier, R., and Messitt, M.

94

TITLE: Vestibular nystagmus in newborn infants

REFERENCE: Neurol., 1961, 11, 450-458

SUBJECTS (Number-age): From premature to 42 wks. N not indicated.

EXPERIMENTAL PROCEDURES: Rotation

FINDINGS:

1. "Rotational and postrotational nystagmus quite similar to that seen in adults should be obtainable in all normal full-term infants and in larger normal premature infants."

2. Tonic deviation without quick component - "The common denominator of these factors appears almost always to be some alteration of the state of consciousness..."

3. "No response...appears to be a sign of grave abnormality of the nervous system."

COMMENT:

INDEX: Rotation

AUTHORS: Perani, G., and Magri, M.

95

TITLE: [Considerations on the behaviour of the vestibular apparatus in senile age]

REFERENCE: Arch. Ital. di Otolologia, Rinologie e Laringologia (Milano), 1965,  
76, 52-57

SUBJECTS (Number-age): 110 Ss (70 to 90 yrs.)

EXPERIMENTAL PROCEDURES: Not indicated

FINDINGS:

Entire Summary: "The AA have had the possibility of examining in a large Geriatric center of Milan a group of 110 subjects considered healthy, aged between 70 and over 90 from the vestibular point of view. The subjects have been classified into three groups according to age. This investigation yielded [sic] some interesting data for a physiological interpretation of the conditions of the senile vestibular apparatus."

COMMENT: English summary only

INDEX: General

AUTHORS: Picart, P., Conraux, C., and Greiner, G.-F.

96

TITLE: Reponse Nystagmique et seuil chez le tout jeune enfant  
[The nystagmic response and threshold in the very young child]

REFERENCE: Rev. de Laryngologie, Otologie, Rhinologie, 1971, 92, 258-261

SUBJECTS (Number-age): "Very young children" - not yet walking

EXPERIMENTAL PROCEDURES: Not indicated

FINDINGS: Not indicated in summary

COMMENT: Brief English summary only

INDEX: General

AUTHORS: Pollack, R. H., and Carter, D. J.

97

TITLE: Subjective median plane as a function of age and source of stimulation

REFERENCE: Percept. Mot. Skills, 1967, 25, 691-692

SUBJECTS (Number-age): 10 boys } (6-14 years. old)  
10 girls }

EXPERIMENTAL PROCEDURES: Adjustment of illuminated square so that it appeared to be straight ahead under various muscular stimulation conditions (basically arm extensions)

FINDINGS:

1. No significant age trend
2. Muscular stimulation was dominated by visual stimulation.

COMMENT:

INDEX: Visual tilt

AUTHOR: Rapin, I.

98

TITLE: Hypoactive labyrinths and motor development

REFERENCE: Clin. Pediat., 1974, 13, 922-937

SUBJECTS (Number-age): 353 children under age of 10 yrs.

EXPERIMENTAL PROCEDURES:

Caloric test, spontaneous and positional nystagmus testing, rotational test

FINDINGS:

"Our own data, here summarized, provide further evidence for the thesis that vestibular dysfunction may delay the achievement of independent sitting and walking in some, but not all, infants."

COMMENT: General review of clinical approaches

INDEX: Caloric, rotation, positional

AUTHORS: Rasmussen, A. T.

99

TITLE: Studies of the VIIth cranial nerve of man

REFERENCE: Laryngoscope, 1940, 50 67-83

SUBJECTS (Number-age): 37 normal vestibular nerves (2 to 60 yrs. old)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

Two basic groups compared: Group 1 (2 to 26 yrs.), Group 2 (44 to 60 yrs.)

1. "There are nearly 1,000 fewer vestibular fibres in the older group."

[However, intra-ear comparison of one individual had difference of 4,000 fibers - apparently normal.]

2. "The older group contained 2,200 fewer cochlear fibres than the younger group."

COMMENT:

INDEX: Histology

AUTHOR: Reason, J. T.

100

TITLE: An investigation of some factors contributing to individual variation in motion sickness susceptibility

REFERENCE: Flying Personnel Research Committee, Report 1277, 1968

SUBJECTS (Number-age): 150 men, 150 women; average age 19.9 yrs. (college undergraduates)

EXPERIMENTAL PROCEDURES: Motion Sickness History Questionnaire

FINDINGS:

1. "Both men and women reported a reduced incidence of motion sickness in the period following the age of 12."

2. "It must be stressed, however, that the present age finding needs to be treated with some caution owing to the narrow age range sampled, and to the retrospective nature of the questionnaire."

COMMENT:

INDEX: Motion sickness

AUTHOR: Rosenhall, U.

101

TITLE: Degenerative patterns in the aging human vestibular neuro-epithelia

REFERENCE: Acta Otolaryng. (Stockh.), 1973, 76, 208-220

SUBJECTS (Number-age): 113 inner ears from 96 Ss (fetus to 95 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. 20% reduction of hair cell population in maculae with age  
40% reduction of hair cell population in cristae ampullares
2. Maculae - significant loss in hair cell population over 70 yrs.  
Canals - loss at about 50-60 yrs.
3. Not many changes prior to 40 yrs.

COMMENT:

INDEX: Histology

AUTHORS: Rosenhall, U., and Rubin, W.

102

TITLE: Degenerative changes in the human vestibular sensory epithelia

REFERENCE: Acta Otolaryng. (Stockh.), 1975, 79, 67-80

SUBJECTS (Number-age): 96 normals (fetal to 95 yrs. old), mainly left ear only,  
plus 6 more Ss (3 normal, 3 with vestibular abnormalities)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

1. No change in size, configuration, or thickness of sensory epithelia
2. Number and size of inclusions increased with age.
3. Loss of sensory hairs with age - more prominent in canals, less in otoliths
4. "The age-related degeneration ultimately resulted in disappearance of sensory cells."

COMMENT: Three case histories (abnormal vestibular function)

INDEX: Histology

AUTHORS: Ross, M. D., Johnsson, L.-G., Peacor, D., and Allard, L. F.

103

TITLE: Observations on normal and degenerating human otoconia

REFERENCE: Ann. Otol., 1976, 85, 310-326

SUBJECTS (Number-age): Two fetuses (15 and 20 wks.), one premature (28 wks.),  
15 patients (3 days to 83 yrs. - 8 of the 15 over 50 yrs.)

EXPERIMENTAL PROCEDURE: Histology

FINDINGS:

1. "In middle and advanced age the otoconia decrease in number, especially in the saccule. Saccular otoconia degenerate progressively in a posteroanterior direction across the macula..."

2. "Neogenesis and growth of otoconia appear to occur postnatally..."

3. "Age-related saccular otoconial degeneration appears to involve the organic material which disappears either before or simultaneously with the mineral substance."

COMMENT:

INDEX: Histology

AUTHORS: Schuknecht, H. F., Igarashi, M., and Gacek, R. R.

104

TITLE: The pathological types of cochleo-saccular degeneration

REFERENCE: Acta Otolaryng. (Stockh.), 1965, 59, 154-170

SUBJECTS (Number-age): 1 cat, 1 dog, 1 human (85 yrs.)

EXPERIMENTAL PROCEDURES: Histology

FINDINGS:

"Although the entire labyrinth is exposed equally to aging, metabolic disturbances, and viral attack, the phylogenetically older pars superior (utricle and canals) is rarely affected."

COMMENT:

INDEX: Histology (human, animal)

AUTHOR: Sheldon, J. H.

105

TITLE: The effect of age on the control of sway

REFERENCE: Gerontologia Clinica, 1963, 5, 129-138

SUBJECTS (Number-age): 268 Ss (116 male and 152 female - 6 yrs. to 80+ yrs.)

EXPERIMENTAL PROCEDURES: Sway test

FINDINGS:

"Improvement in control [of sway] develops rapidly and reaches a plateau which stretches from the late teens until the forties, after which an increasing deterioration sets in."

COMMENT:

Author's observation: Young groups may be representative of average child; older groups are limited to "physical aristocracy."

INDEX: Stability/ataxia

AUTHOR: Silverstein, H.

106

TITLE: Induced rotational nystagmus in normal infants

REFERENCE: J. Pediatrics, 1965, 67, 432-437

SUBJECTS (Number-age): 35 infants (1 to 12 mos.)

EXPERIMENTAL PROCEDURES: Rotational test

FINDINGS:

"Postrotatory nystagmus was active from birth to 5 months of age but was not found in most infants after the age of 6 months."

COMMENT: Manual rotation; observed eye movements; infants were looking at examiner (visual suppression). Seven infants tested with Frenzel glasses with same results.

INDEX: Rotation

AUTHORS: Siroky, A., Krejcova, H., Slavicke, J., and Hanusova, V. 107  
TITLE: Threshold of irritability of the vestibular apparatus in children and in adult subjects  
REFERENCE: Sbornik lekarsky, 1965, 67, 94-100  
SUBJECTS (Number-age): 41 Ss - 10 yrs.; 38 Ss - 20 to 25 yrs.  
EXPERIMENTAL PROCEDURES: Rotation test  
FINDINGS:  
1. "Irritability threshold" higher for young group (18.15 deg/sec) versus older group (9.78 deg/sec).  
2. The lowest angle of acceleration necessary to evoke per-rotatory nystagmus higher in young group (1.02 deg/sec<sup>2</sup>) versus older group (0.60 deg/sec<sup>2</sup>).  
3. "Latency period" for pre- and post-rotatory nystagmus not different.  
COMMENT: English summary  
INDEX: Rotation

AUTHORS: Smith, K. U., and Smith, W. M. 108  
TITLE: Infant control of the behavioral environment  
REFERENCE: In: Smith, K. U., and Smith, W. M. (Eds.), Perception and Motion. Philadelphia, PA: W. B. Saunders Co., 1962.  
SUBJECTS (Number-age): Several groups and experiments (4 mos. to 2 yrs.)  
EXPERIMENTAL PROCEDURES: A playpen that moved as a response to vocalizations  
FINDINGS:  
"We find evidence here that children from 10 to 18 months of age exercise some environmental control through generalized orientation motions, but as a rule do not respond specifically to the object characteristics of the environment. The period between 18 and 26 months is critical for the elaboration of many kinds of motivated space-organized movements which are adapted to control of stimulation."  
COMMENT:  
INDEX: Rotation

AUTHORS: Takemori, S., et al. [Others not listed.]

109

TITLE: Optokinetic pattern test in children

REFERENCE: Otolaryng. (Tokyo), 1971, 43, 3-10

SUBJECTS (Number-age): "Ten normal children of three different age groups, 4, 6, and 8 years old were tested and compared to those higher in age, 10-15 and 21-30 years old."

EXPERIMENTAL PROCEDURES: Optokinetic test

FINDINGS:

"The present study showed that children older than 8 years of age could be regarded as adults in so far as the ability of eliciting optokinetic patterns concerned. In testing younger children of the ages of 4 and 6 years old, it appeared that better responses of nystagmus was [sic] obtained when pictures were used as targets rather than the vertical stripes; especially in elevating the slow phase velocity of nystagmus but not necessarily for increasing the number of nystagmic beats."

COMMENT: English summary only

INDEX: Optokinetic

110

AUTHOR: Tarasov, D. I.

TITLE: Vestibular leukocytic reaction in children

REFERENCE: Vestnik Oto-Rino-Laringologii, 1968, 30, 43-46

SUBJECTS (Number-age): 40 children (3 to 14 yrs.)

EXPERIMENTAL PROCEDURES: Rotation

FINDINGS:

Peripheral blood leukocyte counts change with rotation.

5 revolutions at 180 deg/sec	no change in leukocytes
10-15 revolutions at 180 deg/sec	increase in leukocytes
20 revolutions at 180 deg/sec	decrease in leukocytes

"The authors are of the opinion that vestibular leukocytic reaction may serve as an additional test in vestibulometry in children."

COMMENT: English summary only

INDEX: Rotation, motion sickness

AUTHORS: Tauber, E. S., and Koffler, S.

TITLE: Optomotor response in human infants to apparent motion: Evidence of innateness

REFERENCE: Science, 1966, 152, 382-383

SUBJECTS (Number-age): 19 subjects (10 hrs., 48 min. to 4 days, 10 hrs.)

EXPERIMENTAL PROCEDURES: Stroboscopic optokinetic stimulus

FINDINGS:

"Our results indicate that the optomotor response to apparent (stroboscopic) motion is innate in humans."

No specific trend with regard to age

COMMENT:

INDEX: Optokinetic

AUTHORS: Thoman, E. G., and Korner, A. F.

TITLE: Effects of vestibular stimulation on the behavior and development of infant rats

REFERENCE: Devel. Psychol., 1971, 5, 92-98

SUBJECTS (Number-age): 181 infant rats

EXPERIMENTAL PROCEDURES: Rotation

FINDINGS:

1. "...vestibular stimulation is a highly effective stimulus for arresting the distress call of the infant rat from the first day of life."

2. "The developmental effects of rotation were evident in increased exploratory behavior at 20 days of age and in higher weaning weights."

3. "...the neonatal rat is responsive to vestibular stimulation from the first day of life."

COMMENT: Only a brief daily period of vestibular stimulation (10 min.)

INDEX: Rotation (animal)

AUTHOR: Tibbling, L.

113

TITLE: The rotatory nystagmus response in children

REFERENCE: Acta Otolaryng. (Stockh.), 1969, 68, 459-467

SUBJECTS (Number-age): 84 Ss (newborn to 15 yrs.)

Six groups:

One hr. to 5 days  
3 to 12 mos.  
1 to 3 yrs.  
4 to 6 yrs.  
7 to 9 yrs.  
10 to 15 yrs.

EXPERIMENTAL PROCEDURES: Rotation test - nystagmus

FINDINGS:

1. Speed of slow component decreased with increasing age.
2. Nystagmus amplitude and the speed of fast component decreased with increasing age.
3. Duration of nystagmus shortest in children aged less than 12 months; otherwise, no statistical differences.
4. Nystagmus frequency increased with increasing age.

COMMENT: 10/12 newborn group had no nystagmus during rotation (deviation of eyes in direction of slow component)

INDEX: Rotation

AUTHOR: Tumakov, A. I.

114

TITLE: Effect of sound stimulus on vestibular nystagmus in children

REFERENCE: Zhurnal Ushnykh, Nosovykh I Gorlovykh Boleznei, 1978, 3, 56-60

SUBJECTS (Number-age): 50 children (6 to 12 yrs.)

EXPERIMENTAL PROCEDURES: Caloric test

FINDINGS: (Entire summary)

"The author studied the effect of sound on caloric cold nystagmus in 50 children aged 6 to 12 without pathology of acoustic and vestibular analyzer. It was revealed that caloric nystagmus is weakened under the influence of intensive sound in 90% of cases. The mechanisms of sound effect on vestibular nystagmus are to be studied."

COMMENT: English summary only

INDEX: Caloric

AUTHORS: Uesu, C. T., Eisenman, J. I., and Stemmer, E. A.

115

TITLE: The problem of dizziness and syncope in old age: Transient ischemic attacks versus hypersensitive carotid sinus reflex

REFERENCE: J. Amer. Geriat. Soc., 1976, 24, 126-135

SUBJECTS (Number-age): 7 patients with dizziness

EXPERIMENTAL PROCEDURES: Clinical cardiovascular examination

FINDINGS:

Dizziness and syncope related to transient ischemic attack and hypersensitive carotid sinus reflex

COMMENT:

INDEX: Vertigo/dizziness

AUTHORS: Van de Calseyde, P., Ampe, W., and Depont, M.

116

TITLE: The damped torsion swing test: Quantitative and qualitative aspects of the ENG pattern in normal subjects

REFERENCE: Arch. Otolaryngol., 1974, 100, 449-452

SUBJECTS (Number-age): Uncertain - part of paper describes 150 Ss between 16 and 50 yrs; data show a 5-10 yr. group and a 50+ yr. group.

EXPERIMENTAL PROCEDURES: Torsion swing test

FINDINGS:

"...nystagmus frequency being higher in older people, while amplitude is smaller and frequency nystagmus-threshold for different degrees/sec ( $\alpha$ ) accelerations increase."

COMMENT:

INDEX: Torsion swing

AUTHORS: Van de Calseyde, P., Ampe, W., and Depondt, M.

117

TITLE: Le seuil nystagmique chez l'enfant soumis a l'epreuve pendulaire

REFERENCE: Rev. de Laryngologie Otologie Rhinologie, 1970, 91, 876-880

SUBJECTS (Number-age): N not indicated. Age 5-10 yrs.

EXPERIMENTAL PROCEDURES: Unclear in summary - probably torsion swing test

FINDINGS: (Entire summary)

"The authors have attempted to find the frequency threshold for nystagmus in children from 5 to 10 years old, using pendular stimulation. This study shows that this threshold is often difficult to determine at this age. In cases where a result could be obtained, the threshold seems to be very low.

COMMENT: English summary only

INDEX: Torsion swing test

AUTHORS: Van der Laan, F. L., and Oosterveld, W. J.

118

TITLE: Age and vestibular function

REFERENCE: Aerospace Med., 1974, 45, 540-547

SUBJECTS (Number-age): 334 - caloric

779 - torsion swing

Groups every 10 yrs. from 10 to over 71

EXPERIMENTAL PROCEDURES: Caloric test, torsion swing test, dizziness interview

FINDINGS:

Caloric test - children - large amplitudes and low frequency  
old people - low amplitudes and high frequency

Torsion swing - strongest nystagmus in young people.

Age affected frequency, amplitude, and speed of slow and  
fast phase.

COMMENT:

INDEX: Caloric, torsion swing test, dizziness

AUTHORS: Virolainen, E. S., and Aantaa, E.

119

TITLE: The nystagmus threshold in turning test in different age groups and in patients suffering from otosclerosis

REFERENCE: Acta Otolaryng. (Stockh.), 1976, 81, 127-129

SUBJECTS (Number-age): Three groups:

20 females, average age 20 (19-22)

20 females, average age 42 (36-50)

60 patients - otosclerosis - average age 42 (18-64)

EXPERIMENTAL PROCEDURES: Rotation test (nystagmus threshold)

FINDINGS:

No differences between the normal groups (young/old) in thresholds of acceleration.

Otosclerosis patients had significantly higher thresholds.

COMMENT:

INDEX: Rotation

AUTHORS: Volkmann, F. C., and Pufall, P. B.

120

TITLE: Adjustments of visual tilt as a function of age

REFERENCE: Perception and Psychophysics, 1972, 11, 187-192

SUBJECTS (Number-age): 175 Ss (3 yrs. to 20 yrs.)

EXPERIMENTAL PROCEDURES: Adjusting luminous line

FINDINGS:

1. "There were no significant differences in mean errors of adjustment to the vertical and horizontal over the ages tested."

2. "Older children and adults produced significantly larger mean errors of adjustment to the 45-deg tilt than did the younger children, but the variability of settings by younger children was very high, indicating that they did not discriminate the 45-deg tilt more accurately than the older groups."

COMMENT:

INDEX: Visual tilt

AUTHORS: von Bernuth, H., and Precht1, H.F.R.

121

TITLE: Vestibulo-ocular response and its state dependency in newborn infants

REFERENCE: Neuropaeediatrice, 1969, 1, 11-24

SUBJECTS (Number-age): 27 newborn infants, preliminary study  
6 infants (4-7 days old), final study

EXPERIMENTAL PROCEDURES: Rotation test (rocking) ~ ENG

FINDINGS:

1. "The vestibulo-ocular response as expressed in the horizontal electro-oculogram (EOG) was of high amplitude during wakefulness and irregular sleep, but was markedly diminished or absent during regular sleep."

2. "The phase-angle relationship between sinusoidal stimulus and the EOG response was approximately 180° in wakefulness and irregular sleep, but always larger in regular sleep."

COMMENT:

- a) 5 to 6 hour sessions
- b) two frequencies and two amplitudes of rocking

INDEX: Rotation

AUTHOR: Wapner, S.

122

TITLE: Age changes in perception of verticality and of the longitudinal body axis under body tilt

REFERENCE: J. Exp. Child Psychol., 1968, 6, 543-555

SUBJECTS (Number-age): 96 boys and 96 girls (7 to 17 years)

EXPERIMENTAL PROCEDURES: Two tasks: 1) adjust luminous rod in a dark room to a position that appears vertical; 2) adjust luminous rod to the longitudinal axis of Ss body

FINDINGS:

"It was found: (a) with increase in age, the position of apparent vertical shifts from the side of body tilt to the side opposite tilt; (b) while the apparent location of longitudinal body axis deviates beyond true body tilt in all age groups, after 7 years there is a slight decrease in deviation followed by an accelerated increase after 13 years of age; (c) the angular disparity between apparent vertical and apparent body axis position is relatively small for 7 to 13 year-olds compared with 15 and 17 year-olds; (d) for both tasks, final adjustment of the rod is relatively close to its position at the beginning of the trial, and this effect, greatest at 7 years, decreases with increase in age."

COMMENT:

INDEX: Visual tilt

AUTHORS: White, B. L., and Castle, P. W.

123

TITLE: Visual exploratory behavior following postnatal handling of human infants

REFERENCE: Percept. Mot. Skills, 1964, 18, 497-502

SUBJECTS (Number-age):

18 infants in control group

10 infants in experimental group  
(Age - 60 to 30 days)

EXPERIMENTAL PROCEDURES: Nonspecific handling - no prescribed vestibular stimulus, although rocking was major handling procedure

FINDINGS:

1. "The only difference found was that handled infants showed more visual attentiveness than controls. We believe that this variable is of fundamental significance for early visual-motor development."

2. "The results of this study support the hypothesis that early postnatal handling plays a significant role in determining the amount of visual exploratory behavior seen in human infants."

COMMENT:

INDEX: General

AUTHORS: Zelenka, J., and Slaninova, B.

124

TITLE: Changes of labyrinth function due to age

REFERENCE: Cesk. Otolaryng., 1964, 13, 21-26

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: Rotation test, caloric test

FINDINGS:

"A senile vestibular apparatus has a diminished reactivity to rotation as well as caloric stimulation."

Young people have a hyporeflexia which transitions to normal by approximately 18 yrs.

COMMENT: English summary only

INDEX: Rotation, caloric

AUTHORS: Zelenka, V. J., and Slaninova, B.

125

TITLE: Die tätigkeit des labyrinthes bei kindren zwischen 8 and 14 jahren, die termingerecht oder nach verkürzter schwangerschaftsdauer geboren sind

REFERENCE: Zeitschrift fur Laryngologie, Rhinologie, Otologie und Ihre Grenzgebiete, 1966, 45, 808-813

SUBJECTS (Number-age): Not indicated

EXPERIMENTAL PROCEDURES: Not indicated

FINDINGS: "With increasing age the children's vestibular activity showed a convincing increase."

COMMENT: English summary only

INDEX: General

AUTHORS: Zlotnik, G., Iversen, P. B., Tolstrup, K., and Zilstorff, K.

126

TITLE: Vestibular function of patients in a child psychiatric department

REFERENCE: Danish Med. Bull., 1971, 18, 152-156

SUBJECTS (Number-age): 61 children ( 3 to 16 yrs., average age - 8 yrs.)

EXPERIMENTAL PROCEDURES: Caloric test

FINDINGS:

1. No age-related findings
2. Vestibular malfunction very evident in children with psychotic symptoms

COMMENT: Schizophrenia

INDEX: Caloric

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